# I. Introduction

Charles Sanders Peirce (1839-1914) was a physicist employed (1860-1892) by the United States Coast and Geodetic Survey as Geodicist and expert in the Logic of Science (on Peirce's life, see Fisch (1986), Eisele (1979), Ketner (1998), Samway (1995)). In 1877 he was elected to the National Academy of Sciences on the basis of his work in scientific logic (Quine, 1999). Peirce was one of the developers of mathematical logic in use today in applications such as computing (Putnam (1982), Dipert (1995), Quine (1995), Ketner (1984, 1988) Houser, et al (1997)). Throughout his career he worked to develop a new logic of relations, which by 1897 burst forth as a completely functional diagrammatic approach to the subject, based within a graphical or topological method (Ketner (1986), Burch (1991), Roberts (1973)).

Peirce's ideas, though recognized as profoundly innovative, were not widely used in the physics of the 20th century. A notable exception is the work of David Finkelstein (1988, 1994, 1996) (Finkelstein and Galiautdinov (2001)) who has explored several avenues where Peirce's concepts might be illuminating, ranging from quantum theory to cosmology. Others who have pointed out possible applications are Christiansen (1993), Fernandez (1993), and Schmeikal (2000).

None of these proposed applications has been refined to the point of constituting a specific physical model. We undertake this task in the present work.

The main feature of our model is the use of Peirce's relational logic. We employ a new method of diagrammatization with triadic signs which directly extends Peirce's insights into particle physics. The method also specifically relates to Peirce's principles of tychism and synechism (Peirce (1898, 1891-3)) as will be seen.

This work will proceed as follows:

In Chapter II we give a brief introduction to Peirce's Logic of Relations. A graphical representation of this logic is shown to give not only a very useful way of visualizing how the logical elements fit together (valency and bonding), but also a means for understanding fundamental principles of the logic. The basic nature of the triadic relation becomes more obvious. The type of triadic relation emphasized here, the sign relation, is introduced. Other relevant principles of Peirce, tychism and synechism, are brought in.

In Chapter III three suggestive ideas–time-symmetric wave functions, advanced waves, and Einstein's needle radiation–are scrutinized. These ideas, separately and in combination, introduce an alternate way of looking at elementary particles. We are led to advocate a picture of elementary particles as individual wave bundles comprised of both advanced and retarded waves. These particles travel along, and are concentrated near, timelike or null paths which can point either forward or backward in time.

Chapter IV contains further physical preliminaries which justify certain features of the model, namely, that the theory refers to single particles or wave bundles which interact as quanta, not as fields. The particle interactions are visualized to occur in regions limited in extension in space and time. A correspondence with quantum theory is indicated along with a rationale for the application of triadic graphs.

In Chapter V the diagrammatic model itself is presented. Part A introduces the diagrams (called Peirce/Beil/Ketner (**PBK**) diagrams), Part B gives the correspondence of these diagrams with quantum theory, Part C focuses on a description of the internal structure of elementary particles, and Part D is a study of particle interactions which leads to issues concerning continuity.

Chapter VI presents an outline for the application of the **PBK** method to the design of quantum computers and also shows how the one-particle state picture relates to the conventional multiparticle state viewpoint.

Chapter VII is a concluding discussion of how our model can be applied to a resolution of several interpretational problems in quantum theory.